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DEPTH OF GROUND COVER OVER SHALLOW OBSORPTION SYSTEMS AS AN INFLUENCE ON SEPTIC TANK SOIL PERFORMANCE

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On:

Depth of Ground Cover Over Shallow Absorption Systems as an Influence on Septic Tank Soil Performance

by

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CONCLUSION

For the areas reviewed and reported herein, the depth of ground cover over the soil absorption systems did not significantly affect the failure rates of the systems.

INTRODUCTION

In an effort to determine if septic tank soil absorption system performance is influenced by the depth of ground cover over the system, data from 836 individual septic tank systems have been reviewed. The data were originally collected in connection with two studies being conducted for the Federal Housing Administration by the Public Health Service. Information from Calhoun, Kent, and Ingham Counties in Michigan, Knox County, Tennessee, and Mecklenburg County, North Carolina was obtained in the Seepage Bed Study. Information from Tarrant County, Texas and Polk County, Iowa pertains to narrow trench absorption systems and was obtained in the Food Waste Grinder Study.

The data encompass five climatic areas and a variety of soils ranging from the very poorly drained Iredells of Mecklenburg County to the excessively drained Plainfield sands of Michigan.

DISCUSSION

General.

Septic tank systems from seven field survey sites were selected for this investigation. The systems in similar soils in three Michigan counties were combined as one sample, while those in Mecklenburg County, North Carolina were separated into two samples because of the great difference between system performance in the Cecil and Iredell soils found there. Data for each of the other locations, Tarrant County, Texas, Polk County, Iowa, and Knox County, Tennessee, were handled as individual samples, giving a total of six samples.

Within each sample the failed and satisfactory systems were compared to determine if system age, person loading, and absorption area provided were similar. These comparisons are shown in Tables 1-6, and are discussed separately for each area.

Each of the 6 samples was then divided into 4 groups, 0-11.9, 12-23.9, 24-35.9, and 36-48 inches based on depth of ground cover over the absorption system. In each group system age, person loading, and absorption area provided were compared to determine if systems in the depth groups were comparable, or if factors were present which would tend to cause unusual failure rates in some depth groups (Tables 7-12).

Finally, the distribution of failures as related to depth group was investigated. These distributions are shown in Tables 13-19, and are discussed separately by areas.

Michigan Counties.

The sample for the 3 Michigan counties included 70 systems,(1) 12 of which had failed and 58 of which were operating satisfactorily. All of the systems are clustered in the 12-23.9 and 24-35.9 inch depth groups. Soils in these areas are of a sandy nature.

A comparison of the various performance affecting factors, Table 1, indicates that there is no significant difference in age, person loading, or absorption area provided between the failed and satisfactory systems. The failures in Michigan, then, are not attributable to these biasing factors.

(1) The number of systems reported for each area may differ slightly from the number reported in other studies. A few systems were deleted from some areas since they lacked data essential to this study.

Comparison between the depth groups shows that the systems in the 24-35.9 inch depths have significantly larger average areas provided. However, there is no significant relationship between depth of ground cover and performance.

Tarrant County, Texas.

The Tarrant County sample included 79 cases, 22 failed and 57 satisfactory. All systems are installed in the associated Houston and Denton clay soils.

The failed systems are not significantly different from the satisfactory systems with respect to age, absorption area, and person loading. The systems are comparable by depth groups for person loading and area, but the 8 systems in the 0-11.9 inch depth are significantly older. There is no significant relationship between depth of ground cover and failure rates.

Polk County, Iowa.

The Polk County, Iowa sample consisted of 261 systems, of which 32 had failed and 229 were satisfactory. They are all located in the relatively good Clarion and associated soils.

In Polk County, as in Michigan, all of the systems were distributed in two depth groups.

The failed and satisfactory systems are comparable on the basis of age and absorption area provided; however, the failed systems have a higher mean person loading. The systems in the 24-35.9 inch depth group are significantly older than those in the 12-23.9 inch group and have significantly smaller absorption areas, but there is no significant difference in failure rates.

Knox County, Tennessee.

There are 95 systems included in the Knox County sample, primarily Sequoia and Decatur soils. Forty of the systems had failed and 55 were satisfactory. A comparison of performance affecting factors indicates no significant difference between failed and satisfactory systems.

The systems are distributed over three depth groups. They are comparable between depth groups with respect to age, person loadings, and absorption areas. There is no relationship between depth of ground cover and system failures.

Mecklenburg County, North Carolina - Cecil Soil.

There were 220 systems reviewed in the Cecil soils of Mecklenburg County, 51 failed and 169 satisfactory. There is no difference in age and absorption area provided between the failed and satisfactory systems. The failed systems have a higher mean person loading. The mean age of the 123 systems in the 12-23.9 inch depth group is significantly greater than that of the other groups, but the mean person loadings and absorption areas provided are not significantly different. There is a failure rate of 75 percent in the 0-11.9 inch depth group, but this group contains only 4 of the 220 systems in the sample. There is no significant difference in the over-all distribution of failures with depth.

Mecklenburg County, North Carolina - Iredell Soil.

Of the 111 systems reviewed in the Iredell soils of this area, 75 (67 percent) had failed. The failed systems are comparable to the satisfactory systems with respect to performance influencing factors. These systems are not validly comparable between various depth groups. Person loading and absorption area provided are significantly greater in the deeper systems.

No significant difference in failure rates at different depths is indicated.

Table 1

A Comparison of Performance Affecting Factors for Failed vs. Satisfactory Systems
Calhoun, Kent, and Ingham Counties, Michigan

Factor	Failed Systems		Satisfactory Systems
Number of Cases	12		58
Age (Years)			
Mean	4.0		3.4
Median	4.0		2.8
Range	2.0-8.9		1.2-8.9
Standard Deviation	2.7		1.4
Student's "t" Value		1.37	
Persons			
Mean	4.3		4.2
Median	4.0		3.9
Range	3.2-5.2		2.0-6.0
Standard Deviation	1.0		1.0
Student's "t" Value		0.34	
Absorption Area (Square Feet)			
Mean	296		375
Median	324		327
Range	44-450		67-751
Standard Deviation	119		244
Student's "t" Value		0.39	
Mean Depth of Ground Cover (Inches)	25.2		21.9

Table 2

A Comparison of Performance Affecting Factors for
Failed vs. Satisfactory Systems
Tarrant County, Texas

Factor	Failed Systems		Satisfactory Systems
Number of Cases	22		57
Age (Years)			
Mean	5.5		5.1
Median	7.8		5.7
Range	1.7-10.7		0.9-10.7
Standard Deviation	2.8		2.1
Student's "t" Value		0.7	
Persons			
Mean	4.0		3.6
Median	4.0		3.9
Range	2.0-7.0		1.5-6.8
Standard Deviation	1.2		1.2
Student's "t" Value		1.62	
Absorption Area (Square Feet)			
Mean	843		841
Median	876		878
Range	608-1158		487-1551
Standard Deviation	157		164
Student's "t" Value		0.31	
Mean Depth of Ground Cover (Inches)	22.0		25.4

Table 3

A Comparison of Performance Affecting Factors for Failed vs. Satisfactory Systems Polk County, Iowa

Factor	Failed Systems		Satisfactory Systems
Number of Cases	32		229
Age (Years)			
Mean	4.2		3.4
Median	3.0		2.8
Range	0.6-12.8		0.2-12.2
Standard Deviation	3.2		2.2
Student's "t" Value		1.91	
Persons			
Mean	4.5		3.8
Median	4.0		3.8
Range	2.0-11.0		1.0-10.1
Standard Deviation	2.0		1.4
Student's "t" Value		2.47*	
Absorption Area (Square Feet)			
Mean	814		840
Median	804		787
Range	278-1255		451-2209
Standard Deviation	252		292
Student's "t" Value		0.48	
Mean Depth of Ground Cover (Inches)	17.6		17.7

*Indicates Student's "t" significance at 95 percent level for Tables 1-6.

Table 4

A Comparison of Performance Affecting Factors for
Failed vs. Satisfactory Systems
Knox County, Tennessee

Factor	Failed Systems		Satisfactory Systems
Number of Cases	40		55
Age (Years)			
Mean	8.6		8.0
Median	9.0		8.5
Range	1.2-17.0		2.2-13.1
Standard Deviation	2.6		2.9
Student's "t" Value		1.04	
Persons			
Mean	3.5		3.2
Median	3.0		3.1
Range	2.2-4.8		1.5-4.7
Standard Deviation	0.7		1.1
Student's "t" Value		1.41	
Absorption Area (Square Feet)			
Mean	425		437
Median	404		402
Range	303-600		250-675
Standard Deviation	72		104
Student's "t" Value		0.01	
Mean Depth of Ground Cover (Inches)	27.3		29.1

Table 5

A Comparison of Performance Affecting Factors for Failed vs. Satisfactory Systems
Mecklenburg County, North Carolina - Cecil Soil

Factor	Failed Systems		Satisfactory Systems
Number of Cases	51		169
Age (Years)			
Mean	5.6		5.4
Median	5.2		4.8
Range	1.9-7.8		0.7-10.5
Standard Deviation	1.7		1.9
Student's "t" Value		0.75	
Persons			
Mean	3.6		3.3
Median	3.4		3.2
Range	2.0-7.0		1.0-5.0
Standard Deviation	1.7		1.0
Student's "t" Value		2.34*	
Absorption Area (Square Feet)			
Mean	570		555
Median	536		518
Range	370-908		136-912
Standard Deviation	132		183
Student's "t" Value		0.56	
Mean Depth of Ground Cover (Inches)	22.7		23.3

Table 6

A Comparison of Performance Affecting Factors for Failed vs. Satisfactory Systems
Mecklenburg County, North Carolina - Iredell Soil

Factor	Failed Systems		Satisfactory Systems
Number of Cases	75		36
Age (Years)			
Mean	3.3		3.9
Median	3.0		4.2
Range	0.2-7.1		0.2-8.4
Standard Deviation	1.5		2.2
Student's "t" Value		1.86	
Persons			
Mean	3.7		3.7
Median	3.2		3.8
Range	0.3-6.0		2.0-6.0
Standard Deviation	1.3		1.0
Student's "t" Value		0.40	
Absorption Area (Square Feet)			SEE NOTE 1:
Mean	645		630
Median	521		558
Range	380-936		341-960
Standard Deviation	173		186
Student's "t" Value		0.37	
Mean Depth of Ground Cover (Inches)	24.4		27.3

Note 1: Only 53 failed and 30 satisfactory cases are reported since all absorption areas were not recorded in the original surveys.

Table 7

A Comparison of Performance Affecting Factors in Each Depth Group
Calhoun, Kent, and Ingham Counties, Michigan

Factor	Failed Systems	Satisfactory Systems	Failed and Satisfactory Systems Combined
Number of Cases	12	58	70
Mean Ages in Each Depth Group (Years)			
12-23.9 Inches	3.9	3.5	3.5
24-35.9 "	4.5	3.2	3.5
			F Value** = 0.04
Mean Number of Persons in Each Depth Group			
12-23.9 Inches	4.8	4.2	4.1
24-35.9 "	4.2	4.4	4.4
			F Value = 0.73
Mean Absorption Area in Each Depth Group (Square Feet)			
12-23.9 Inches	285	326	313
24-35.9 "	351	498	465
			F Value = 8.11*
Number of Food Waste Grinders in Each Depth Group			
12-23.9 Inches	0	20	20
24-35.9 "	2	10	12

*Indicates F significance at the 95 percent level for Tables 7-12.

**The F Values refer to an Analysis of Variance of the means of the Failed and Satisfactory Systems combined in each depth group.

Table 8

A Comparison of Performance Affecting Factors in Each Depth Group
Tarrant County, Texas

Factor	Failed Systems	Satisfactory Systems	Failed and Satisfactory Systems Combined
Number of Cases	22	57	79
Mean Ages in Each Depth Group (Years)			
0-11.9 Inches	10.1	7.9	8.7
12-23.9 "	4.6	5.0	4.9
24-35.9 "	4.1	4.8	4.6
			F Value = 14.80*
Mean Number of Persons in Each Depth Group			
0-11.9 Inches	3.4	1.8	3.0
12-23.9 "	4.3	3.8	3.9
24-35.9 "	4.3	3.5	3.7
			F Value = 1.35
Mean Absorption Area in Each Depth Group (Square Feet)			
0-11.9 Inches	884	713	819
12-23.9 "	781	825	814
24-35.9 "	869	856	867
			F Value = 1.15
Number of Food Waste Grinders in Each Depth Group			
0-11.9 Inches	0	0	0
12-23.9 "	1	1	2
24-35.9 "	3	11	14

Table 9

A Comparison of Performance Affecting Factors in Each Depth Group
Polk County, Iowa

Factor	Failed Systems	Satisfactory Systems	Failed and Satisfactory Systems Combined
Number of Cases	32	229	261
Mean Ages in Each Depth Group (Years)			
12-23.9 Inches	4.4	3.3	3.2
24-35.9 "	4.6	3.8	4.1
			F Value = 11.83*
Mean Number of Persons in Each Depth Group			
12-23.9 Inches	4.6	3.9	3.9
24-35.9 "	4.0	3.8	3.8
			F Value = 0.95
Mean Absorption Area in Each Depth Group (Square Feet)			
12-23.9 Inches	808	888	879
24-35.9 "	820	785	790
			F Value = 7.65*
Number of Food Waste Grinders in Each Depth Group			
12-23.9 Inches	13	86	99
24-35.9 "	10	49	59

Table 10

A Comparison of Performance Affecting Factors in Each Depth Group
Knox County, Tennessee

Factor	Failed Systems	Satisfactory Systems	Failed and Satisfactory Systems Combined
Number of Cases	40	55	95
Mean Ages in Each Depth Group (Years)			
12-23.9 Inches	7.8	9.2	8.5
24-35.9 "	9.1	7.7	8.4
36-48 "	8.8	6.2	7.1
			F Value = 1.12
Mean Number of Persons in Each Depth Group			
12-23.9 Inches	3.6	3.5	3.6
24-35.9 "	3.5	3.2	3.3
36-48 "	3.3	3.1	3.2
			F Value = 0.76
Mean Absorption Area in Each Depth Group (Square Feet)			
12-23.9 Inches	444	385	412
24-35.9 "	417	448	436
36-48 "	406	464	444
			F Value = 0.79
Number of Food Waste Grinders in Each Depth Group			
12-23.9 Inches			
24-35.9 "		None	
36-48 "			

Table 11

A Comparison of Performance Affecting Factors in Each Depth Group
Mecklenburg County, North Carolina - Cecil Soil

Factor	Failed Systems	Satisfactory Systems	Failed and Satisfactory Systems Combined
Number of Cases	51	169	220
Mean Ages in Each Depth Group (Years)			
0-11.9 Inches	3.9	4.7	4.1
12-23.9 "	6.3	5.9	6.0
24-35.9 "	4.7	4.9	4.8
36-48 "	4.3	3.3	4.0
			F Value = 11.50*
Mean Number of Persons in Each Depth Group			
0-11.9 Inches	3.8	4.0	3.9
12-23.9 "	3.7	3.1	3.3
24-35.9 "	3.2	3.3	3.2
36-48 "	5.4	2.8	3.4
			F Value = 0.50
Mean Absorption Area in Each Depth Group (Square Feet)			
0-11.9 Inches	603	486	574
12-23.9 "	548	552	549
24-35.9 "	582	573	576
36-48 "	698	586	605
			F Value = 0.74
Number of Food Waste Grinders in Each Depth Group			
0-11.9 Inches	0	0	0
12-23.9 "	0	7	7
24-35.9 "	5	5	10
36-48 "	0	1	1

Table 12

A Comparison of Performance Affecting Factors in Each Depth Group
Mecklenburg County, North Carolina - Iredell Soil

Factor	Failed Systems	Satisfactory Systems	Failed and Satisfactory Systems Combined
Number of Cases	75	36	111
Mean Ages in Each Depth Group (Years)			
12-23.9 Inches	3.5	4.3	3.7
24-35.9 "	3.0	3.9	3.4
36-48 "	2.1	2.8	2.4
			F Value = 1.56
Mean Number of Persons in Each Depth Group			
12-23.9 Inches	3.5	3.6	3.5
24-35.9 "	3.8	3.8	3.8
36-48 "	4.5	3.7	4.1
			F Value = 4.56*
Mean Absorption Area in Each Depth Group (Square Feet)		See Note 1, Table 6, Page 11	
	N = 53	N = 30	N = 83
12-23.9 Inches	609	552	591
24-35.9 "	684	661	675
36-48 "	885	672	726
			F Value = 4.71*
Number of Food Waste Grinders in Each Depth Group			
12-23.9 Inches	9	2	11
24-35.9 "	14	4	18
36-48 "	3	1	4

Table 13

Performance of Systems in Each Depth Group
Calhoun, Kent, and Ingham Counties, Michigan

Depth of Systems and Performance	Number Failed	Number Satisfactory	Percent Failed
12-23.9 Inches	6	38	13.6
24-35.9 "	6	20	23.1
Chi Squared Value = 0.47			

Table 14

Performance of Systems in Each Depth Group
Tarrant County, Texas

Depth of Systems and Performance	Number Failed	Number Satisfactory	Percent Failed
0-11.9 Inches	5	3	62.5
12-23.9 "	7	24	22.6
24-35.9 "	10	30	25.0
Chi Squared Value = 5.97			

Table 15

Performance of Systems in Each Depth Group
Polk County, Iowa

Depth of Systems and Performance	Number Failed	Number Satisfactory	Percent Failed
12-23.9 Inches	18	145	11.8
24-35.9 "	14	84	18.2
Chi Squared Value = 0.84			

An asterisk behind the Chi Squared Value would indicate Chi Squared significance at the 95 percent level for Tables 13-18. No values are significant.

Table 16

Performance of Systems in Each Depth Group
Knox County, Tennessee

Depth of Systems and Performance	Number Failed	Number Satisfactory	Percent Failed
12-23.9 Inches	13	12	52.0
24-35.9 "	23	35	39.7
36-48 "	4	8	33.3
Chi Squared Value = 1.73			

Table 17

Performance of Systems in Each Depth Group
Mecklenburg County, North Carolina - Cecil Soil

Depth of Systems and Performance	Number Failed	Number Satisfactory	Percent Failed
0-11.9 Inches	3	1	75.0
12-23.9 "	28	95	22.8
24-35.9 "	17	65	20.6
36-48 "	3	8	27.2
Chi Squared Value = 6.59			

Table 18

Performance of Systems in Each Depth Group
Mecklenburg County, North Carolina - Iredell Soil

Depth of Systems and Performance	Number Failed	Number Satisfactory	Percent Failed
12-23.9 Inches	36	12	75.0
24-35.9 "	35	20	63.7
36-48 "	4	4	50.0
Chi Squared Value = 2.78			